Statement by Dr. John Peter Buwalda, Geologist

California Tax Digest herewith presents the report of Dr. John Peter Buwalda, Professor of Geology, California Institute of Technology; collaborator with Carnegie Institution of Washington, D. C., in the development of a great Seismological Laboratory at Annandale, Cal.; Associate Geologist of the U. S. Geological Survey; formerly Professor of Geology at Yale University, and at the University of California, Berkeley.

By JOHN P. BUWALDA
Professor of Geology, California Institute of Technology

In view of the different plans being considered for the building of high dams San Gabriel Canyon a statement of the ological conditions as they affect impounding structures in that drainageway may be pertinent and of interest.

The writer's examination of the canyon reveals that the geological conditions from its mouth to the forks are quite similar, differing only in minor details. The dominant rocks are gneiss and a variety of coarse-grained intrusive igneous rocks of the general nature of granites and diorites. Dikes of both acid and basic rocks are common. Quartz and calcite veins occur occasionally.

Structurally the San Gabriel Canyon from its mouth to the forks is a zone along which the rocks have been somewhat fractured. No evidence was seen indicating that a single fault extends the length of the canyon, but the rocks are somewhat shattered. It is highly probable that the course of the San Gabriel River from its forks to the mouth of the canyon has been determined in a general way by the presence of the belt of fractured rocks, since these are eroded down more rapidly than firmer rock masses.

The evidence for the existence of a fracd zone consists of (a) unusually fret jointing or breaking of the rocks into blocks, large and small, in the bedrock as exposed in cliffs and stream bottoms, (b) slickensides and grooved rock surfaces, usually standing at steep angles, (c) bands of brecciated or fragmented rock produced by crushing of the walls along minor faults within the fracture zone, (d) notches in the profiles of spurs which extend transversely into the canyon from east and west; the notches indicate lines of weakness susceptible to rapid erosion and are best explained as fracture zones in the otherwise rather homogeneous rocks. The slickensides, breccia zones, and notches are roughly parallel to the general trend of the canyon.

The distribution on the ground of the jointing, slickensides, breccia and fracture notches indicates a width for the broken zone of several hundred feet, at least in places, and continuity from the mouth of the canyon to the forks. Many fracture zones in California are of this nature.

JOHN P. BUWALDA

The shattering of this zone resulted from repeated slipping along parallel planes of displacement in the remote past and it is highly improbable that the canyon is still an active zone of movement. Evidences of recent activity and movement such as are found in the active San Andreas rift are: sag ponds, longitudinal slice ridges within the valley, displacement horizontally or vertically of transverse ridges, diversion of tributary drainage channels from their normal courses within the canyon or valley. These evidences are absent in San Gabriel canyon.

The foregoing geological data bear on the following considerations:

Depth of Waste. Drilling is reported to

have shown that the gravel in the canyon is of 60 to 70 feet maximum thickness, both where drilling was done near the forks and at two sites in the lower canyon. The topography and geology of the canyon indicate that the thickness at other sites might be somewhat greater or less, but will not be found either to increase to several times this thickness or to decrease to a small fraction of this figure.

The weathered rock which will have to be removed from the walls of the canyon for safe abutment of the dam will probably not exceed 20 or 30 feet as a maximum. At the sites in the lower canyon the weathered waste on the walls is somewhat thinner than just below the forks, due to the steeper slopes of the canyon walls.

Judging from the condition of the bedrock at the bases of the stream cliffs and from drill cores the bedrock beneath the gravels lying in the canyon is relatively fresh and it will not be necessary to remove more than a few feet unless it is desired to sink the base of the dam in a trench or to put down a shutoff wall.

Foundation and Anchorage. Being made of very strong and firm rocks, the walls and bedrock floor of San Gabriel Canyon will support without serious yielding a dam of 400 or 500 feet in height provided alluvial waste and any decayed bedrock be removed. There is no reason to believe that landslides have occurred recently, or are imminent in the next few centuries either at the site near the forks or at the four sites in the lower canyon which the writer examined, including the so-called Granite Dike Site.

Danger from Fault Slip. As already indicated the fracture zone marking San Gabriel Canyon shows no evidence of recent activity, and the danger of a fault slip shearing a dam in the canyon at any of the sites under consideration is very slight.

A fault doubtless passes in an east-west direction along the canyon occupied by the two forks of the San Gabriel River and within a mile of the damsite near the forks. Another fault quite certainly lies at the south base of the range and passes in an east-west direction across the mouth of the canyon, within one to two miles of the Granite Dike and nearby sites. Neither of these faults is generally regarded as active by California geologists. Neither fault would pass beneath any of the proposed dams. Should a slip occur on either of these two faults the resulting earthquake if very severe might damage a dam at either the upper or lower sites, but this possibility is rather remote.

Seepage. Because of the somewhat f[illegible] sured condition of the rocks in the fracture zone marking San Gabriel Canyon, there is manifestly some danger that the seepage through the rocks under and around a dam so high as to create hydrostatic pressure at its base approaching that in a locomotive boiler might be excessive. A certain amount of seepage may not be objectionable inasmuch as it may be planned to permit a considerable amount of water to discharge from the reservoir continuously in any case. As contrasted with escape of water through soluble or easily erodable rocks such as certain sedimentary formations, excessive seepage is not in general as dangerous in gneisses and intrusive igneous rocks because the latter formations are practically unerodable and the channels of escape therefore will not enlarge appreciably. But zones of brecciated and powdered rock along the minor fracture planes might erode and channels in them might enlarge to dangerous proportions. While this danger does not seem serious it cannot be eliminated entirely from consideration in San Gabriel Canyon.

Comparison of Sites. The geological conditions at the proposed damsite i[illegible] in the forks of San Gabriel River and at [illegible] in so-called Granite-Dike site, as well as at three other sites near the latter which were examined, are approximately equally favorable as regards thickness of waste, foundation and anchorage, danger from fault slip and seepage.

Geologically, the proposed locations are all *good* damsites but not ideal, in that the surrounding country is traversed by a number of faults and a certain possibility of excessive seepage exists.